PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project Steelhead Supplementation Studies in Idaho Rivers	
BPA project number	**9005500**
Contract renewal date (mm/yyyy)	**01/2000**
Multiple actions? (indicate Yes or No)	**yes**
Business name of agency, institution or organization requesting funding **Idaho Department of Fish and Game**	
Business acronym (if appropriate)	**IDFG**
Proposal contact person or principal investigator:	
Name	**Alan Byrne**
Mailing address	**1414 East Locust Lane**
City, ST Zip	**Nampa, Id 83868**
Phone	**208-465-8404**
Fax	**208-465-8434**
Email address	**abyrne@idfg.state.id.us**
NPPC Program Measure Number(s) which this project addresses 3.3B.1, 4.1A, 4.1B, 4.2A, 4.3C, 5.0F.7, 7.1C.3, 7.1D.1, 7.1F.3, 7.1H.1, 7.3B.1, 7.3B.2**,** 7.4A.1, 8.4A, 8.4B, 10.5A	
FWS/NMFS Biological Opinion Number(s) which this project addresses Biological Opinion. Reinitiation of Consultation on 1994 - 1998 Operation of the Federal Columbia River Power System and Juvenile Transportation Program in 1995 and Future Years. Issued March 2, 1995.	
Other planning document references Columbia Basin System Planning, Salmon and Steelhead Production Plan, Clearwater Subbasin, pages 117 - 186. Columbia Basin System Planning, Salmon and Steelhead Production Plan, Salmon River Subbasin, pages 175 - 251. Idaho Department of Fish and Game, Anadromous Fish Management Plan 1992 - 1996.	
Short description Evaluate the feasibility of using artificial production to increase natural steelhead populations and to collect life history, genetic, and disease data from wild steelhead populations in Idaho**.**	
Target species **steelhead trout (*Oncorhynchus mykiss*)**	

Section 2. Sorting and evaluation

Subbasin Clearwater and Salmon

Evaluation Process Sort

CBFWA caucus	CBFWA eval. process	ISRP project type
X one or more caucus	If your project fits either of these	X one or more categories

		processes, X one or both			
x	Anadromous fish	x	Multi-year (milestone-based evaluation)		Watershed councils/model watersheds
	Resident Fish		Watershed project eval.		Information dissemination
	Wildlife				Operation & maintenance
					New construction
				x	Research & monitoring
					Implementation & mgmt
					Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
8909800	Idaho supplementation studies (ISS)	juvenile steelhead PIT-tagged and scales collected at ISS screw traps, obtain juvenile steelhead densities from their snorkel surveys.
8909801	Salmon supplementation studies in Idaho rivers-USFWS	juvenile steelhead PIT-tagged and scales collected at ISS screw traps, obtain juvenile steelhead densities from their snorkel surveys.
8909802	Salmon supplementation studies in Idaho rivers-Nez Perce Tribe	juvenile steelhead PIT-tagged and scales collected at ISS screw traps, obtain juvenile steelhead densities from their snorkel surveys.
8909803	Salmon supplementation studies in Idaho rivers-Shoshone-Bannock Tribe	juvenile steelhead PIT-tagged and scales collected at ISS screw traps, obtain juvenile steelhead densities from their snorkel surveys.
9107300	Idaho natural production monitoring and evaluation	this project uses steelhead PIT-tagged by SSS for smolt-to-adult survival analysis. SSS supplies GPM data.
9600600	PATH - Facilitation, Tech. Assistance & Peer Review	supply adult and juvenile steelhead density and escapement data for the PATH process
9600900	PATH - Participation by State and Tribal Agencies	supply adult and juvenile steelhead density and escapement data for the PATH process
9700200	PATH - UW Technical support	supply adult and juvenile steelhead density and escapement data for the PATH process
8909600	Monitor, evaluate genetic characteristics of supplemented salmon and steelhead	Coordinate data collection and analysis.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1992	I submitted a detailed experimental design to BPA for this project	

1993	We outplanted adult hatchery steelhead from Sawtooth Hatchery in Beaver and Frenchman creeks	The study design called for wild fish to be stocked also. We were unable to obtain wild fish this spring because streams were high and turbid during the period we attempted to collect them.
1993	SF Red River was stocked with 50,000 hatchery fingerlings.	First year of the four yearly fingerling stockings of Objective 2, task b.
1993	Crews snorkeled 8 streams to obtain juvenile steelhead densities.	Yes, data used to monitor steelhead population status and spawning success of outplanted hatchery adult steelhead.
1993	Crews PIT-tag 2,870 juvenile steelhead in 6 streams.	Yes, data used for population status, emigration patterns from streams, smolt emigration timing at Snake River dams, and for smolt-to-adult survival (SAR) analysis.
1994	We outplanted adult hatchery steelhead from Sawtooth Hatchery in Beaver and Frenchman creeks.	The study design called for wild fish to be stocked also. We did not collect wild adults because of the low escapement into Idaho.
1994	SF Red River was stocked with 50,000 hatchery fingerlings.	Second year of the four yearly fingerling stockings of Objective 2, task b.
1994	Crews snorkeled 8 streams to obtain juvenile steelhead densities.	Yes, data used to monitor steelhead population status and spawning success of outplanted hatchery adult steelhead.
1994	Crews PIT-tag 6,314 juvenile steelhead in 12 streams.	Yes, data used for population status, emigration patterns from streams, smolt emigration timing at Snake River dams, and for smolt-to-adult survival (SAR) analysis.
1994	Crews collected scales from juvenile steelhead in 5 stream and adults from 3 streams	Juvenile scales used to determine freshwater age. Adults scales used for adult age.
1995	We outplanted hatchery adult steelhead from Sawtooth Hatchery in Beaver Creek	We did not collect wild adults because of the low escapement into Idaho. There were not enough returning hatchery fish to stock Frenchman Creek this year.
1995	Stock 50,000 hatchery fingerlings in SF Red River	Third year of the four yearly fingerling stockings of Objective 2, task b.
1995	We installed a temporary weir in Fish Creek and counted the adult escapement.	Data used as an index of the status of wild B-run steelhead in Idaho.
1995	Crews snorkeled 8 streams to obtain juvenile steelhead densities.	Yes, data used to monitor steelhead population status and spawning success of outplanted hatchery adult steelhead.
1995	Crews PIT-tag 3,431 juvenile steelhead in 7 streams	Yes, data used for population status, emigration patterns from streams, smolt emigration timing at Snake River dams, and for smolt-to-adult survival (SAR) analysis.
1995	Crews collected scales from juvenile steelhead in 4 streams and adults from 5 streams.	Juvenile scales used to determine freshwater age. Adults scales used for adult age
1996	We outplanted hatchery adults from Sawtooth Hatchery in Beaver Creek	We did not collect wild adults because of the low escapement into Idaho. There were not enough returning hatchery fish to stock Frenchman Creek this year.
1996	Stock 50,000 hatchery fingerlings in SF Red River	Final year of the four yearly fingerling stockings of Objective 2, task b.
1996	We stocked 5,000 hatchery smolts in Red River	First year of the four yearly smolt stockings of

		Objective 2, task c.
1996	We installed a temporary weir in Fish Creek and counted the adult escapement.	Data used as an index of the status of wild B-run steelhead in Idaho.
1996	Crews PIT-tag 7,998 juvenile steelhead in 11 streams.	Yes, data used to monitor steelhead population status and spawning success of outplanted hatchery adult steelhead.
1996	Crews snorkeled 12 streams to obtain juvenile steelhead densities.	Yes, data used for population status, emigration patterns from streams, smolt emigration timing at Snake River dams, and for smolt-to-adult survival (SAR) analysis.
1996	Crews collected scales from juvenile steelhead in 2 streams and adults in 1 stream	Juvenile scales used to determine freshwater age. Adults scales used for adult age
1997	We outplanted hatchery adults from Sawtooth Hatchery in Beaver and Frenchman creeks	We did not collect wild adults because of the low escapement into Idaho.
1997	We stocked 5,000 hatchery smolts in Red River	Second year of the four yearly smolt stockings of Objective 2, task c.
1997	We installed a temporary weir in Fish Creek to count adult escapement	Data used as an index of the status of wild B-run steelhead in Idaho.
1997	Crews snorkeled 13 streams to obtain juvenile steelhead densities.	Yes, data used to monitor steelhead population status and spawning success of outplanted hatchery adult steelhead.
1997	Crews PIT-tag about 9,200 juvenile steelhead in 11 streams	Yes, data used for population status, emigration patterns from streams, smolt emigration timing at Snake River dams, and for smolt-to-adult survival (SAR) analysis
1997	We collected scales from juvenile steelhead in 4 streams and adults from 2 streams	Juvenile scales used to determine freshwater age. Adults scales used for adult age
1997	We collected fin samples for future DNA analysis from juvenile steelhead in 4 streams and adults in 2 streams.	Samples will be used to develop genetic stock structure database.
1998	We outplanted hatchery adult steelhead from Sawtooth Hatchery in Beaver Creek	We did not collect wild adults because of the low escapement into Idaho.
1998	We stocked 5,000 hatchery smolts in Red River	Third year of the four yearly smolt stockings of Objective 2, task c.
1998	We installed a temporary weir in Fish Creek to count adult escapement.	Data used as an index of the status of wild B-run steelhead in Idaho.
1998	Crews snorkeled 10 stream to obtain juvenile steelhead densities	Yes, data used to monitor steelhead population status and spawning success of outplanted hatchery adult steelhead.
1998	Crews PIT-tag about 6,700 juvenile steelhead in 11 streams	Yes, data used for population status, emigration patterns from streams, smolt emigration timing at Snake River dams, and for smolt-to-adult survival (SAR) analysis
1998	We collected scales from juvenile steelhead in 3 streams and adults in 2 streams	Juvenile scales used to determine freshwater age. Adults scales used for adult age
1998	We collected fin samples for future DNA analysis from juvenile steelhead in 6 streams and adults in 2 streams.	Samples will be used to develop genetic stock structure database.
1998	We mounted and aged 432 adult steelhead scales and 2,766 juvenile steelhead scales that were collected from 1993 to 1997.	Created database and developed relation between length of scale radii and age.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Assess the performance of hatchery and wild brood sources to reestablish steelhead in streams where extirpated. Evaluate the brood sources in a hatchery and natural stream environment.	a	In stream: Outplant adults from each brood source into isolated and vacant habitat that is suitable for steelhead production using a paired watershed approach for three consecutive years. Study streams will be tributaries of the Salmon River upstream of the Sawtooth Hatchery. Enclose the section of stream where adults are stocked with picket weirs. Monitor spawning activity.
1		b	In stream: Estimate parr production by snorkel surveys, trapping juvenile emigrants, and PIT-tagging.
1		c	In stream: Estimate the smolt yield and number of emigrants from each brood year in streams by trapping and from PIT-tag detections at mainstem dams.
1		d	In hatchery: Spawn and rear in the hatchery wild and hatchery brood sources for three consecutive years. Determine percent eye-up, survival, growth, health, and condition factor to the smolt stage of each brood source. Each brood source will be handled and reared equivalently, but in separate raceways. The in-hatchery studies will be done at Sawtooth Hatchery.
		e	In hatchery: Release PIT-tagged smolts at weir sites to coincide with natural smolt migration. Using PIT tag detections, measure travel time and estimate survival to Lower Granite Dam of outplanted smolts from each brood source.
1		f	In hatchery: Identify the brood source of adults returning to the weir. Compare smolt-to-adult survival, sex ratio, length, weight, age, fecundity, and timing of return of adults of each brood source.
1		g	Estimate recovery rates and the frequency of supplementation required to establish viable steelhead populations from results tasks a- f. Establish and maintain a library of supplementation research done elsewhere that will give insight into recovery and frequency rates of supplementation. Establish contacts and exchange information with other agencies involved with research that is pertinent to supplementation.
2	Evaluate the ability of returning adults from hatchery smolt and fingerling releases to produce progeny in natural streams.	a	Snorkel the South Fork Red River and Red River upstream of the South Fork Red River each summer to obtain baseline juvenile steelhead parr densities.

Obj 1,2,3	Objective	Task a,b,c	Task
2		b	Stock 50,000 marked (45,000 with CWT and 5,00 PIT-tagged) fingerlings reared at Clearwater Hatchery into the South Fork Red River in early September for four consecutive years (done 1993 - 1996).
2		c	Stock 5,000 PIT-tagged smolts reared at Clearwater Hatchery into Red River in April, upstream of the South Fork Red River, for four consecutive years (1996 -1999). The lag between stocking smolts and fingerlings was planned so that most smolts from each group migrate to the ocean the same year(s).
2		d	Operate the Red River weir to catch returning adult steelhead from 1997 - 2003. Determine the origin of adults and sex, measure length, and pass upstream.
2		e	Snorkel SF Red River and Red River yearly. Compare parr production per female of each group when adults return.
2		f	Estimate recovery rates and the frequency of supplementation required to establish viable steelhead populations from results tasks 1- 5.
3	Assess the abundance, habitat, and life history characteristics of existing wild steelhead populations in the Salmon and Clearwater river drainages.	a	Use existing weirs and traps to document the timing, number, length, and age (from scale sampling) of wild juvenile steelhead in selected streams. We are PIT-tagging all steelhead juveniles > 75 mm at all ISS screw trap locations, Fish Creek, Boulder Creek, and Rapid River.
3		b	Estimate wild adult steelhead escapement in indicator streams. Record length of adults, sex ratio, age, and date of return. We are collecting this data from hatchery weir sites on Clear Creek, Rapid River, Pahsimeroi River, and the Salmon River at Sawtooth Hatchery. We install a temporary weir each spring in Fish Creek.
3		c	Record temperature throughout the year in selected streams in the Salmon and Clearwater drainages. Presently, we are recording temperatures in 40 streams.
3		d	Snorkel streams that can serve as indicators of steelhead population within the major drainages. Fish Creek and Gedney Creek are being used as indicator streams for the Lochsa and Selway drainages, respectively.
3		e	Using the PIT-tagged fish from traps identified in task a estimate steelhead out-migration from each stream using mark-recapture methodologies, determine growth rate from recaptured fish, develop smolt

Obj 1,2,3	Objective	Task a,b,c	Task
			migration timing through the mainstem Snake River using dam detections, and estimate smolt-to-adult survival.
3		f	Collect wild juvenile steelhead from 50 streams to develop a genetic stock structure of Idaho steelhead populations.
4	Evaluate broodstock management at existing hatchery weirs in relation to IDFG natural production objectives.	a	Review existing policy for passing adults and stocking hatchery fry, fingerlings, and smolts upstream of hatchery weirs. Monitor adult escapement, juvenile densities, and smolt production upstream of the weir sites.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measurable biological objective(s)	Milestone	FY2000 Cost %
1	04/93	12/09	Estimate parr and smolt production of outplanted adult steelhead.	estimated parr production yearly since 1994.	3%
2	06/93	12/04	Compare juvenile production in streams of adults that were stocked as fingerlings or smolts.	adults will begin returning in 1999, parr production will be compared in years 2000 - 2004.	5%
3	03/93	12/09	Monitor wild juvenile and adult abundance in index streams. Collect life-history and habitat data from wild steelhead populations. Determine genetic stock structure of wild populations within Idaho.	yearly adult escapement and snorkel surveys used to estimate wild steelhead abundance, PIT-tag data used for emigration timing, smolt migration through mainstem rivers and smolt-to-adult survival studies.	90%
4	03/93	12/09	Monitor steelhead escapement at hatchery weirs and juvenile production upstream of the weirs.		2%
				Total	100%

Schedule constraints

Because steelhead are now listed under ESA, we must obtain permits from NMFS to continue the research we began in 1993, however IDFG does not anticipate any restrictions of the research in progress. The lack of wild adult returns has prevented us from initiating Objective 1 as planned, however IDFG has outplanted hatchery adults as outlined in tasks a - c . We are viewing this as a "case study" to determine if the Sawtooth Hatchery stock can be used to re-establish steelhead in vacant habitat in the upper Salmon River drainage.

Completion date

This project is designed to help achieve recovery of ESA listed steelhead trout and is expected to continue until recovery is attained. Recovery of steelhead should mimic that of chinook salmon and is not expected until 2024 (U. S. Department of Commerce, NOAA, 8/97 Draft of the Snake River Salmon Recovery Plan).

Section 5. Budget

FY99 project budget (BPA obligated):	**$258,000**

FY2000 budget by line item

Item	Note	% of total	FY2000 ($)
Personnel	salaries for permanent and seasonal staff	22.8	127,813
Fringe benefits	includes all employee benefits	7.5	41,934
Supplies, materials, non-expendable property		2.2	12,060
Operations & maintenance		6.1	38,060
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		0.4	2,000
NEPA costs			
Construction-related support			
PIT tags	# of tags: 8,000	4.1	23,200
Travel	includes travel for permanent staff and all subsistence needs for field work	2.4	13,230
Indirect costs			
Subcontractor	genetic analysis of 2,500 steelhead juveniles for stock structure ($100/fish)	44.6	250,000
Other	Agency overhead (22.5% of personnel and operating)	9.4	52,447
	TOTAL BPA REQUESTED BUDGET		560,744

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		Total project cost (including BPA portion)	

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	273,000	281,000	289,000	297,000

Section 6. References

Watershed?	Reference
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PART II - NARRATIVE

Section 7. Abstract

The Northwest Power Planning Council identified supplementation to generate much of the increases to meet its goal of doubling anadromous fish runs in the Columbia River. The goal of supplementation: an increase in natural production, is a departure from previous hatchery management. Guidelines and procedures for supplementation are not established. This project was designed to investigate potential benefits and risks with small-scale experiments and to develop protocols for biologically sound steelhead supplementation. We used the Regional Assessment of Supplementation Project (RASP) guidelines to formulate the research design.

The major objectives of this research are:

1. Assess the performance of hatchery and wild brood sources to reestablish steelhead in streams where extirpated.

2. Evaluate the ability of returning adults from hatchery smolt and fingerling releases to produce progeny in natural streams.
3. Collect and monitor population status, life history attributes, and genetic data from wild steelhead populations in key indicator tributaries of the Salmon and Clearwater drainages.

We minimized the risk to natural populations of steelhead and chinook salmon by choosing study streams for Objectives 1 and 2, that are vacant of steelhead or are no longer managed as viable populations. We are monitoring wild juvenile and adult abundance with weirs, snorkel surveys, and screw traps, in key production streams that can serve as indicators of the steelhead status within Idaho. We plan to describe the genetic stock structure of steelhead within Idaho, by sampling populations throughout the state.

Section 8. Project description

a. Technical and/or scientific background

The Northwest Power Planning Council (NPPC) has identified supplementation as a high priority to achieve its interim goal of doubling anadromous fish runs in the Columbia River basin (NPPC 1987). In the System Planning process, over 70% of the total planned increases in steelhead *Oncorhynchus mykiss* production in the Columbia River basin were attributed to supplementation (D. Anderson, NPPC, personnel communication in RASP 1992). In the Snake River basin 95% of the A-run and 72% of the B-run planned steelhead production increases were expected from supplementation. All naturally produced steelhead in Idaho were listed as a threatened species under the Endangered Species Act in 1997.

Hatchery production and supplementation have existed in the Columbia Basin for over 100 years but rigorous scientific evaluation of supplementation on natural production is sparse and results discouraging (Smith et al. 1985; Miller et al. 1990; Stewart and Bjornn 1990; Hindar et al. 1991). The few studies that evaluated the effect of supplementation on naturally produced salmonids found that hatchery fish did not perform as well as natural fish (Chilcote et al. 1986; Nickelson et al. 1986; Leider et al. 1990). An assessment of supplementation objectives, benefits, and risks should occur prior to implementation. Idaho Department of Fish and Game (IDFG) proposes this research to assess supplementation risks.

The major supplementation question that needs to be resolved is whether it is possible to integrate artificial and natural production without an unacceptable risk to natural populations. Potential supplementation risks include: reducing natural productivity below sustainable levels through genetic introgression with a less fit supplementation stock, displacement of naturally produced fish through behavioral interactions with supplementation fish, transmission of diseases, excessive straying of returning hatchery adults, taking too many wild adults into the hatchery for supplementation, and inadvertent selection or domestication of donor stocks brought into the hatchery. These risks should be addressed prior to the implementation of large scale stocking programs.

The goal of supplementation is to increase natural fish production using artificial propagation without a negative impact on the productivity or abundance of existing natural fish populations. Providing a sustainable benefit from supplementation without an improvement in passage conditions is highly unlikely (Byrne, et al. 1992). For supplementation to be beneficial, we believe our hatcheries must propagate a fish that is compatible with existing natural stocks. This approach represents a departure from conventional hatchery practice in that success is measured by the ability of returning adults to produce viable offspring in the natural stream environment. Guidelines and procedures to accomplish this new hatchery goal are not established. Research is required to resolve the risks and uncertainties associated with integrating artificial and natural production.

We propose a series of short-term studies that address specific hypotheses about supplementation methods and to gather baseline population status, life-history, and genetic data from wild populations. Although a supplementation program will not be implemented, the Regional Assessment of Supplementation Project (RASP) guidelines for supplementation programs were used to formulate the research design. We focus on baseline data collection from wild steelhead populations within Idaho (RASP steps 2 and 3), an analysis of limiting factors (RASP step 4), methods to increase steelhead abundance (RASP step 6), and the assessment of risks and benefits of supplementation methods (RASP step 7). The results of this research will be used to guide steelhead supplementation decisions in Idaho. This research provides information to help achieve the goals of the Columbia River Basin Fish and Wildlife Plan (FWP) outlined in Section 4 (establishing principles to met the Salmon and Steelhead doubling goal), Section 5 (by PIT-tagging wild steelhead stocks for flow, travel time, and survival studies), and Section 7 (by collecting life-history, genetic, and abundance data on wild populations in Idaho).

This project also monitors the status of wild steelhead populations in Idaho. Adults are counted at hatchery weirs at Rapid River, Clear Creek, Pahsimeroi River, Red River, and the Salmon River at Sawtooth Hatchery and with a temporary weir at Fish Creek. We intensively snorkel streams yearly to monitor juvenile densities. We operate screw traps at Fish Creek, Boulder Creek, and Rapid River to monitor parr and smolt emmigration. Juveniles are PIT-tagged at these sites and at ISS screw trap locations. We use the PIT-tag data in smolt-to-adult survival studies, estimating smolt production, and estimaing juvenile growth rates in streams. Idaho lacks a statewide comphrensive genetic stock structure of its wild steelhead populations. This project will collect steelhead samples from populations throughout the Clearwater, Salmon, and Snake drainages and coordinate their genetic analysis. The results of this analysis will allow us to develop a genetic stock identifcation database of our wild steelhead populations.

b. Rationale and significance to Regional Programs

The Steelhead Supplementation Study investigates: (1) strategies and develops protocols that may be used in a supplementation program to increase the abundance of naturally produced steelhead and (2) monitors populations and life-history characteristics of wild steelhead populations. This project cooperates and shares data with the Nez Perce Tribe, Shoshone-Bannock Tribe, U.S. Fish & Wildlife Service, Lower Snake River Compensation Plan, and the U.S. Forest Service.

Objective 1: This objective investigates supplementation methods and helps achieve the FWP goals in Section 4.2A of reducing scientific uncertainty and increasing knowledge to increase fish runs and Section 4.3 to develop rebuilding targets and plans. Information gathered by this project can be used by IDFG fish managers in an adaptative management framework (FWP, Section 3.2).
Objective 2: This objective investigates supplementation methods and helps achieve the FWP goals in Section 4.2A of reducing scientific uncertainty and increasing knowledge to increase fish runs and Section 4.3 to develop rebuilding targets and plans. Information gathered by this project can be used by IDFG fish managers in an adaptative management framework (FWP, Section 3.2).

Objective 3: The data collected from this objective helps met the goals of the FWP Section 7 and 8 as follows: (1) 7.0-population status of adults and juveniles can be used to update and keep current Subbasin Plans, (2) 7.1B, 8.4A, 8.4B-the genetic analysis of wild populations enables us to identify and conserve genetic diversity and to describe the stock structure within Idaho, (3) 7.1C and 7.1D-data collected allows us to maintain long term databases and to develop a profile on the population status, genetic, life-history, and morphological characteristics and to protect and manage wild populations. (4) This project monitors bull trout population status and gathers life-history information at Rapid River. This meets goals of the FWP Section 10.5A.

Objective 4: This objective furthers the FWP goals of Sections 7.1F, 7.1G, and 7.1H by better managing hatchery stocks to minimize negative impacts on existing wild/natural populations.

c. Relationships to other projects

This project was integrated into many existing IDFG projects and relies on regional and hatchery personnel to assist with the tasks outlined in the study design. Examples include cooperation with snorkel surveys, redd counts, and operating screw traps. Hatchery fish for this study are provided by the Clearwater and Sawtooth hatcheries. Sawtooth Hatchery personnel and Salmon Regional personnel assist us in outplanting adults in tributaries of the Salmon River upstream of Sawtooth Hatchery. Personnel from Rapid River help operate the screw trap located there. Personnel from this project have assisted Rapid River Hatchery personnel handle, sort, and spawn chinook salmon This project provides data on resident fish, steelhead and chinook salmon to IDFG managers in the Lewiston, McCall, and Salmon regions and the Headquarters Fisheries Bureau. This project provides data used in the PATH process and the Steelhead Managers Symposium which is a group of managers from all West Coast states and British Columbia that meets every two years.

Other cooperative efforts include:

4. Idaho Department of Transportation at Lowell plows snow off roads in the early spring so we can install the adult weir and screw trap in Fish Creek.
5. U.S. Fish & Wildlife Service hatchery at Kooskia provides storage area for the Fish Creek weir

and other equipment used at Fish Creek.

6. The Nez Perce Tribe, Shoshone-Bannock Tribe, and U.S. Fish and Wildlife Service provide snorkel data and PIT-tag steelhead at screw traps they operate.

d. Project history (for ongoing projects)

The steelhead supplementation study experimental design was written in 1992 and submitted to BPA in December, 1992. The field work began in 1993. This project has outplanted hatchery adult steelhead and estimated parr production yearly in Beaver and Frenchman creeks from 1993 - 1998. We stocked hatchery fingerlings each fall from 1993 - 1996 and estimated summer parr abundance from 1993 - 1998 in the South Fork Red River. We stocked hatchery smolts in Red River and estimated smolt survival and travel time to Lower Granite Dam from 1996 - 1998. The final smolt stocking in Red River will be done in April 1999. We expect adults to return from the fingerling and smolt stockings beginning in 1999. This project has developed several databases for wild steelhead in Idaho. We have done yearly snorkel surveys of key indicator steelhead streams and have assembled the information into a database. We have monitored wild adult escapement, sex ratios, and age at hatchery weirs sites and Fish Creek. Juvenile steelhead age, length, condition factor, growth rates, migration patterns, and number of migrants has been documented yearly at 6-12 streams with screw traps. We have PIT-tagged over 32,500 wild steelhead parr and smolts since 1993 and created databases with number tagged, length, weight, and other relevant information. We have detected over 6,500 wild steelhead smolts at the mainstem dams and have developed a database with tag site, release date, release length and weight, detection site and date, and travel time into a database. We have a wild steelhead age/length database, based on scale analysis, for adults (n = 432) and juveniles (n = 2,766) collected from indicator streams in the Salmon and Clearwater drainages. We began a long-term stream temperature database in 1993 and are monitoring temperatures in 40 indicator streams in the Salmon and Clearwater drainages. In addition to gathering and providing information on wild steelhead status, this project has provided managers with bull trout escapement, out-migrant numbers and timing, and has PIT-tagged juvenile bull trout and cutthroat trout at Rapid River and Fish Creek.

Project reports include:

Byrne, Alan. 1994. Steelhead supplementation studies in Idaho rivers. Experimental Design. Idaho Department of Fish and Game, Boise. 90 pp.

Byrne, Alan. 1995. Steelhead supplementation studies in Idaho rivers. 1993 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project 90-055. Idaho Department of Fish and Game, Boise. 60 pp.

Byrne, Alan. 1997. Steelhead supplementation studies in Idaho rivers. 1994 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project 90-055. Idaho Department of Fish and Game, Boise. 90 pp.

Byrne, Alan. In Press. Steelhead supplementation studies in Idaho rivers. 1995 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project 90-055. Idaho Department of Fish and Game, Boise. 97 pp.

e. Proposal objectives

1) Objective 1: Assess the performance of hatchery and wild brood sources to reestablish steelhead in streams where extirpated.

Hypothesis: There is no difference among different brood sources to establish natural production.

Ideally, supplementation utilizing various brood sources would be assessed at the population level by releasing different broods of fish into separate drainages and tracking fish abundance, survival, and life history attributes (sex ratio, fecundity, size, etc.) over several generations for each population. Because of the large number of streams and fish that would be required, risks associated with supplementation uncertainties, and the desire to expedite feedback,

we have partitioned this research hypothesis into four chronological components (RASP 1992) which will be tested somewhat independently: in-hatchery survival, post-release survival, reproductive success, and long-term fitness.

In-hatchery (egg-to-smolt) and post release (smolt-to-Lower Granite Dam and smolt-to-adult) survival will be measured directly, providing information within 2-4 years. Adult returns from these releases will probably be inadequate to establish populations and measure reproductive success or long-term fitness. Even if the adult returns are adequate, inferences concerning reproductive success and long-term fitness could not be made until 5-8 years after the research was initiated. Because of these factors, reproductive success and long-term fitness will be assessed indirectly with separate groups of fish. These experiments will be implemented concurrently with the in-hatchery and post release survival experiments. The surrogate for reproductive success will be juvenile age 1 production from adult outplants of each brood source into vacant habitat. If enough adults can be outplanted, successfully spawn, and smolt production monitored, smolt yield can be used as a surrogate for long-term fitness. Experiments designed for this objective will be done in the Salmon River tributaries upstream of Sawtooth Hatchery.

Products: The egg-to-smolt survival, growth rate, and post-release smolt-to-adult survival of hatchery reared wild and hatchery brood sources of fish will be calculated. The number of parr and smolts produced per female from wild and hatchery brood sources outplanted in streams will be estimated.

2) Objective 2: Evaluate the ability of returning adults from hatchery smolt and fingerling releases to produce progeny in natural streams.

Hypothesis: There is no difference between fingerling or smolt stockings in establishing natural steelhead production as measured by F_1 age 1 juvenile abundance.

Our research will focus on life stage of release using an established hatchery stock. We will compare the abundance of age 1 steelhead parr produced by naturally spawning adults that were released as hatchery fingerlings or smolts. Because of limited research opportunities we will use only an established hatchery brood stock(s) to test this hypothesis. Fingerlings (rather than fry) were chosen since the fish can be marked and PIT tagged prior to release into the study streams. The primary evaluation point will be age 1 parr abundance but tasks are included to monitor the subsequent smolt production. This objective is being investigated in the Red River drainage, a tributary of the South Fork Clearwater using Dworshak hatchery stock reared at Clearwater Hatchery.

Products: Estimates of the survival from stocking to returning adult and the reproductive success of the adults can help managers chose the appropriate life stage to release fish for supplementation.

3) Objective 3: Assess the abundance, habitat, and life history characteristics of wild steelhead populations in the Salmon and Clearwater river drainages.

Data collected for this objective will address the following questions identifies by RASP: (1) what were the historical stream and stock characteristics, (2) what is the current status, trend, and performance attributes of steelhead stocks within Idaho, (3) are habitat and survival adequate for supplementation to be successful, and (4) how do we best match donor to recipient stocks and habitat requirements for supplementation.

We are intensively monitoring wild/natural steelhead populations in Fish Creek (Lochsa River tributary), Rapid River (Salmon River tributary), Clear Creek (Middle Fork Clearwater River), Pahsimeroi River and the Salmon River upstream of Sawtooth Hatchery by enumerating adult escapement with weirs, yearly snorkel surveys for juvenile densities, and trapping out-migrants with screw traps and PIT-tagging them to estimate smolt yield, travel time, life-history attributes, and migration patterns to Lower Granite Dam. In Gedney Creek (Selway River tributary) we intensively monitor the population status with yearly snorkel surveys and PIT-tag 600 - 1,200 juveniles collected during the summer. We intensively snorkel 4-6 additional Lochsa River tributaries yearly to monitor population status. We are recording temperatures in streams throughout the state. In FY2000 we propose to sample 50 wild steelhead streams throughout the state and determine the genetic stock structure within Idaho.

Products: We will measure wild adult escapement, sex ratio, and determine age structure from indicator streams. We will maintain a database of juvenile parr densities in indicator steelhead streams. At the screw trap sites we will estimate the number of migrants, determine length frequency, condition factor, migration pattern, age of fish from scale analysis, growth rate from scales and PIT-tagged fish that are recaptured. The survival, arrival timing, and migration through the mainstem Snake River of wild steelhead smolts can be monitored with the fish we PIT-tag. We can estimate wild smolt-to-adult survival using the PIT-tagged fish. We plan to do a genetic analysis of wild steelhead stocks to determine our stock structure and create a genetic stock identification database. We have a stream temperature database that has temperatures from 40 steelhead production streams since 1993. Data collected from this objective may be used to match donor and recipient stocks for supplementation purposes.

4) Objective 4: Evaluate brood stock management at existing hatchery weirs in relation to natural production goals.

We will review existing policy for adults, stocking hatchery fry, fingerlings, and smolts upstream of the weir and in other streams . At each weir site, where there are natural production goals upstream, gather adult return, sex ratio, age structure, and timing of returning hatchery and natural adults. If changes are implemented they will be evaluated to assess the effects on natural and hatchery production. Most of this information for this objective is available from hatchery reports and other monitoring projects.

Products: This project will centralize data from Kooskia Hatchery (Clear Creek), Sawtooth Hatchery (Salmon River), Pahsimeroi Hatchery, Rapid River Hatchery, East Fork Salmon River Satellite Facility, Crooked River Satellite Facility, and the Red River Satellite Facility and coordinate collection and monitoring tasks with hatchery and regional IDFG personnel.

f. Methods

A detailed experimental design that includes, objectives, methods, study area, tasks, assumptions, and statistical and power analysis was submitted to BPA in December, 1992 (Byrne 1994).

Tasks

Objective 1

A) In-hatchery component

1. Collect wild adults and transport to Sawtooth Hatchery.
2. Spawn and rear wild and hatchery fish equivalently but in separate raceways.
3. Develop a length and fecundity relation for each brood source.
4. Measure length and weight monthly, and survival to smolt release.
5. Transport 500 smolts from each brood source to Marrowstone Field Station (USGS, National Biological Service) and do a 3 month sea water growth and survival test.
6. Differentially mark the brood sources, release at the same time, and determine survival from egg-to-smolt and smolt-to-adult.

7 Repeat for three or four consecutive years.

B) Stream component

7. Outplant equal numbers of wild and Sawtooth Hatchery adults into two separate streams upstream of Sawtooth Hatchery.
8. Monitor spawning and estimate egg deposition in each stream.
9. Snorkel streams to estimate juvenile parr abundance yearly.
10. Estimate out-migration with traps, PIT-tag migrants, and estimate smolt yield.
11. Repeat for three or four consecutive years.

Objective 2

12. Stock the South Fork Red River with 50,000 fingerlings (5,000 PIT-tagged and 45,000 CWT) in September for four consecutive years. This tasks was done from 1993 to 1996.
13. Snorkel South Fork Red River and Red River upstream of the South Fork each summer to obtain steelhead parr densities.
14. Stock Red River upstream of the South Fork with 4,000 PIT-tagged smolts for four consecutive years beginning in April 1996. The time lag was planned so most of the smolts produced from the fingerling stockings migrate to the ocean the same year(s) of the smolt releases. The last smolt release will be made in April 1999.
15. Operate the Red River hatchery weir to determine the adult return from each group f rom 1999 - 2003.
16. Compare parr production from adults that return to spawn in Red River and South Fork Red River.

Objective 3

1 Monitor wild/natural adult escapement, length frequency, sex ratios, and arrival timing at hatchery weirs and Fish Creek each year.
2 Monitor wild steelhead parr densities in indicator streams of the Clearwater and Salmon drainages with yearly snorkel surveys during the summer.
3 Operate screw traps in Fish Creek, Boulder Creek, and Rapid River. Estimate out-migration with mark-recapture methodology, measure length, weight, and collect scales from migrants. PIT-tag all steelhead > 70 mm. Coordinate with other IDFG projects and other agencies to PIT-tag steelhead at screw traps operated for the chinook supplementation study.
17. Record the stream temperature on a yearly basis from streams throughout the Clearwater and Salmon drainages.
18. Collect 50 juvenile steelhead per stream from 50 streams throughout Idaho to determine the genetic stock structure of Idaho populations.

Objective 4

19. Obtain wild adult steelhead escapement, lengths, and sex ratios from hatchery weir sites and maintain a wild escapement database.
20. Assist hatchery and regional IDFG personnel monitor steelhead abundance upstream of weirs and evaluate any changes that are made in brood stock management at hatchery weirs.

Statistical Design

Experiments can be analyzed with a completely randomized factorial design or t-tests to test for in-hatchery growth, condition factor, and health differences among brood stocks. Since most of the experiments in this study will be repeated on a yearly basis for three to four years, the data will be analyzed upon completion of the experiments with ANOVA using a repeated measures design (split plot in time).

Analysis of the adult return from one smolt release can be done using the standard chi-square test for independence. Log-linear models will be used to analyze several years of smolt releases and adult returns. Log linear models are a good method for analysis of survival data of known numbers of smolt releases since we are dealing with ordinal (count) data. Green and MacDonald (1987) used log-linear models to analyze several years of hatchery return data.

Several nonparametric statistics will be used for data analysis. Kolomogorov-Smirnov statistics will be used to test for differences in distribution functions of spawning time, time of emigration, and time of smolt migration. A Cox-Stuart test for trend will be used to test for changes in adult escapement and juvenile densities if changes are made at existing weir sites and the binomial test can be used to test for changes in sex ratios.

The comparison of wild and hatchery brood source in streams (Objective 1) and parr production from fingerlings and smolts (Objective 2) are being viewed as case studies using a paired watershed design. We do not have enough fish or streams to assess the experiments otherwise. I did a power analysis using a split plot in time design, power of 80%, CV of 20%, and $\propto = 0.1$ and determined that we would need 6 streams per brood source or life stage to detect a 50% difference in parr and smolt abundance.

g. Facilities and equipment

The personnel, equipment, and infrastructure of IDFG is used to do this research. Project field personnel live in existing IDFG structures, trailers, or camping equipment. All field equipment needed for this research such as, vehicles, screw traps, PIT-tagging gear, snorkeling gear, nets, waders, etc have been purchased. Items that need to be replaced due to wear or use (wet suits, waders, etc) are include in the yearly Operations & Maintenance budget. IDFG has enough existing office for personnel of this project. Office and field computers and software need to be upgraded occasionally to utilize new technologies.

h. Budget

The proposed FY 2000 budget increase from the FY 1999 budget is due to genetic sampling of wild steelhead populations to determine stock structure. Within Idaho, there has never been a comprehensive genetic stock structure analysis done for steelhead. We propose to sample the major steelhead streams within the Clearwater, Salmon, and Snake drainages to identify the steelhead stock structure. There is no comphrensive genetic data set within Idaho based on electrophoreis and we are uncertain at this time whether we will analyize the samples with electrophoresis or DNA techniques. For budget purposes I used the cost for DNA analysis. The biggest portion of the FY 2000 budget ($250,000) is for the analysis of the samples we plan to collect. I also had to budget for a crew to collect and archive the samples. If the genetic sampling is omitted, then the FY2000 budget request would increase to $265,000 to cover inflation costs. In FY 2001 and beyond the budget will drop (estimate $273,000 for FY01 and $293,000 for FY04, increases from FY 1999 primarily to cover inflation) since genetic sampling will not be done yearly.

Section 9. Key personnel

The principle investigator and project leader of this IDFG research is Alan Byrne, Senior Fisheries Research Biologist. Alan obtained a BA in biology from Potsdam State College (1974) and a MS in Fisheries from the University of Idaho (1988). He was employed by the U.S. Fish and Wildlife Service, National Fisheries Research Center, Seattle, WA as a Fisheries Research Biologist from 1988 - 1991 before accepting his present position with Idaho Fish and Game in January 1992.

List of Publications:

Byrne, A., T.C. Bjornn, and J.D. McIntyre. 1992. Modeling the response of native steelhead to hatchery supplementation programs in an Idaho river. North American Journal of Fisheries Management 12:62-78.

Byrne, Alan. 1994. Steelhead supplementation studies in Idaho rivers. Experimental Design. Idaho Department of Fish and Game, Boise. 90 pp.

Byrne, Alan. 1995. Steelhead supplementation studies in Idaho rivers. 1993 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project 90-055. Idaho Department of Fish and Game, Boise. 60 pp.

Byrne, Alan. 1997. Steelhead supplementation studies in Idaho rivers. 1994 Annual Report to the U.S. Department of Energy, Bonneville Power Administration. Contract No. DE-B179-89BP01466, Project 90-055. Idaho Department of Fish and Game, Boise. 90 pp.

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Section 10. Information/technology transfer

Information from this project is made available to IDFG fisheries managers by memos and reports that summerize pertinent information several times each year. An annual progress report is prepared yearly and a five year summary report of this research will be written in 1999. Data from this study is used by scientists involved in the PATH

process. The fish abundance data is incorporated into the STREAMNET database and all PIT-tag data is entered into the PITAGIS database maintained by the Pacific States Marine Fisheries Commission. This research will submit several articles to professional fisheries journals in the future on supplementation strategies, steelhead life history and survival, growth, and migration patterns gained from our PIT-tag studies.

Congratulations!